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Companionship Preference and Dominance in the Social Interaction of Young Chimpanzees

VINCENT NOWLIS

From Yale Laboratories of Primate Biology

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COMPANIONSHIP PREFERENCE AND DOMINANCE
IN THE SOCIAL INTERACTION OF YOUNG
CHIMPANZEES¹

VINCENT NOWLIS

From Yale Laboratories of Primate Biology

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I. INTRODUCTION

Of the factors which influence social interaction in the chimpanzee, mutual attraction of individuals is an outstanding one. Investigations of such aspects of social behavior as imitation

¹ An abridgment of a dissertation presented to the Faculty of the Graduate School of Yale University in candidacy for the degree of Doctor of Philosophy. The writer is greatly indebted to Professor Henry W. Nissen and to Professor Robert M. Yerkes for their counsel and aid in the design, execution, and interpretation of this investigation.

(Crawford and Spence, 1939), communication and coöperation (Crawford, 1937, 1940), food-sharing (Nissen and Crawford, 1936), sexual relations (Yerkes and Elder, 1936), dominance and competition (Yerkes, 1939, 1940), have indicated either directly or indirectly that further consideration must be given to the manner and degree in which mutual adient responses are exhibited and reinforced in these animals. All the evidence indicates that the instigations to get and to keep the company of another animal and to engage in mutually satisfactory activities with it are important factors in chimpanzee behavior.

Chimpanzees born in the Yale Laboratories of Primate Biology usually have been separated from their mothers by the end of the first year of life and kept in groups of two or more until late adolescence. During the period of growth from infancy to adolescence a great variety of social behavior is exhibited by the chimpanzee, and various adaptations to the social and physical environment are acquired. Companionship preference, a special form of the mutual attraction of individuals, is one of the most striking phenomena exhibited during this period. In a group of three or more of these animals, preference is indicated not only by the constant association of two animals, but also in the struggle which often occurs between two rivals for the privilege of walking or sitting quietly with a third animal, or of engaging it in grooming or play activity.

Investigations of social preference in other animals have been made by Murchison (1935), Pattie (1936), and Bayroff (1936). Murchison found in his work on *Gallus domesticus* that male chicks more frequently approached the less dominant of two imprisoned chickens, and that female chicks approached the more dominant member of the pair more frequently. Pattie was interested in the difference in response of chicks reared in isolation and of chicks reared in groups when presented simultaneously with a group of two chicks and a group of two white mice. Preferences for both the chick group and the mouse group were established, the direction of the preference depending both on the experience of the test animal in its living-quarters and the length of its experience in the experimental situation.

Bayroff's study of the effect of isolation on the social response of white rats is also relevant here, although he presented the test animal not with a choice between other animals, but between a compartment containing animals (two white rats confined in a small cell) plus food and one containing only food, or between one containing the stimulus animals and an empty compartment. He found a few cases in which the presence of the stimulus animals was preferred to their absence; in general, position preferences prevented the appearance of social preferences.

A second factor of great importance in chimpanzee interaction is relative dominance status. Yerkes (1939, 1940), Maslow (1936, 1940), and Zuckerman (1932) have clearly indicated the influence of dominance relations in primate social behavior, particularly in the sexually mature animal. The characteristic friendly attitudes of the chimpanzee have been found in several of these studies (Yerkes, 1939; Maslow, 1940) to complicate the expression of dominance.

In the present investigation an attempt is made to identify and measure both the relative preference status and the relative dominance status of the members of a small homogeneous group of pre-adolescent chimpanzees, to determine the relation of dominance status to preference status, and to detect the influence of relative status on the interaction of the subjects when paired in various situations; namely, behavior in a relatively small cage with or without a grille between the partners, behavior after 8 hours and after 23 hours of isolation, and behavior when food was available to only one of the partners.

II. GENERAL PROCEDURE AND SUBJECTS

There were four distinct chronological periods in this investigation, as shown in table 1. During the first period, which extended from February 15 to September 18, 1938, preliminary exploratory work was done to develop methods for testing companionship preferences and for recording social behavior. With the exception of the interval from August 1 to September 18, the eight young chimpanzees used as subjects were kept in solitary living-quarters and were allowed to have social contacts

with each other only when they were in the apparatus used in this study. Casual contacts were, of course, unavoidable, and occurred at such times as when animals were transported from room to room or when their vocalizations were heard in other rooms. Five animals were selected from this group to serve as regular subjects in the work which followed.

TABLE 1
Showing the course of experimentation during 1938-1939

DATES	LIVING CONDITIONS	SUBJECTS	EXPERIMENTS
February 15- September 18, 1938	Isolated at all times	Beta Dick Don Gamma Hal Helene Rosy Tom	Preliminary
September 18- November 2, 1938	Isolated at all times	Dick Don Helene Rosy Tom	1st series: tests of companionship preference
November 3, 1938- January 7, 1939-	Complete isolation until November 13; thereafter isolated during day only	Dick Don Gamma Helene Tom	Exploratory
January 8- March 3, 1939	Isolated during day only	Dick Don Gamma Helene Tom	2d series: tests of companionship preference, dominance status, food-sharing, social behavior in no-barrier situation

During the second period, which extended from September 18 to November 2, these five animals were tested for companionship preferences in a total of 600 three-minute tests. The subjects were isolated at all times except when in the testing apparatus. This part of the study is hereafter referred to as the *first series* of preference trials.

During the third period, extending from November 3, 1938, to January 7, 1939, an unsuccessful attempt was made to develop a more rapid method of testing companionship preferences. The loss of one subject by death on November 13 necessitated use of another animal from the original group of eight, and also resulted in a change in the living routine of the colony. The five subjects were henceforth isolated only during the day. At night they were placed in two adjacent living rooms in rotating groups of two and three. The groups were changed nightly so that each animal had an equal amount of companionship with each of the others. This arrangement of partial isolation was continued to the end of the investigation in March.

During the fourth and final period, which extended from January 8 to March 3, called hereafter the *second series*, tests were made concurrently of preferences, dominance status, and of food-sharing. Observations were also made of the animals, caged in pairs, in a detention chamber with no barrier between the individuals. Throughout the total 1560 three-minute preference tests of the first and second series and the 160 three-minute observation periods in the "no-barrier" situation, a second-by-second record was made of the behavior of the test animal and of the relevant behavior of the other animals with it.

Of the six animals used in the main part of this investigation, Dick, Don, Helene, and Tom were used in both the first and second series. Rosy was used in the first series and died soon after its completion. Gamma replaced Rosy in the second series. Each group of five animals included three males, one of which was a castrate, and two females. The animals formed a relatively homogeneous group: all were born in the Orange Park Station of the Yale Laboratories of Primate Biology between the years of 1932 and 1934. The oldest animal, Gamma, was only twenty months older than the youngest, Don. All were pre-adolescent. All had had somewhat similar general social experience, as is indicated in the following brief synopses of their life histories:

Dick, male. Date of birth: July 15, 1933. Parents: Bill and Josie.

Dick spent his first year with Josie and another mother-infant

pair. He was separated from this group at the age of twelve months, and from that time until his transfer to New Haven in 1937 he had continuous companionship with all the subjects used in this investigation except Gamma. In New Haven he was caged with either Rosy or Don or both until isolated in February, 1938. Weight: 19.5 kilograms.

Don, male (castrated at 20 months). Date of birth: May 2, 1934. Parents: Pan and Nana.

Don spent his first three months with both Pan and Nana (Yerkes, 1936), and during the next seven months lived alone with Nana. He was then placed in the young animal group and caged variously with Dick, Helene, Rosy, Tom, and others. After separation from his mother his record of cagemates both in Florida and New Haven is very much the same as that of Dick and Rosy. Weight: 18.64 kilograms.

Gamma, female. Date of birth: September 21, 1932. Parents: Bill and Nana.

Gamma was separated permanently from Nana when nine months old. Her cagemates at Orange Park, 1933-1935, and those at New Haven included only three other animals, Ben, Beta, and Gua, none of which was used in this investigation. She was first caged with Dick, Don, Helene, Rosy, and Tom in August, 1938. Weight: 20.9 kilograms.

Helene, female, twin of Tom. Date of birth: June 26, 1933. Parents: Pan and Mona.

Helene and Tom lived with Mona until July, 1934 (Tomilin and Yerkes, 1935). At this time the twins were placed in the young animal group, which was soon to include also Dick, Don, and Rosy. In July, 1938, they were sent to New Haven where they had their first contact with Gamma. Weight: 21.6 kilograms.

Rosy, female. Date of birth: April 21, 1934. Parents: Jack and Dita.

Rosy was separated from Dita in March, 1935. From this time until the beginning of the investigation her caging record is practically the same as that of Dick and Don. The death of Rosy in November, 1938, necessitated the use of Gamma in the second series of tests. Weight: 17.5 kilograms.

Tom, male, twin of Helene. Date of birth: June 26, 1933. Parents: Pan and Mona.

The caging record of Tom is practically the same as that of Helene. These animals were separated occasionally for only short periods until the beginning of this investigation. Weight: 24.4 kilograms.

III. TESTS OF COMPANIONSHIP PREFERENCE

A. Method and apparatus

As has already been indicated, casual observations in the animal living-quarters often yield examples of companionship preference which are spontaneously exhibited by the young chimpanzee, usually either in the form of the constant association of two animals or in the form of conflict between two for the privilege of association with a favored animal. The designing of a situation to be used for measuring companionship preference had to meet the following requirements: (1) Competition between two animals for the company of a third had to be eliminated in order to get a fair test of the preferences of each animal. It was therefore necessary to test one animal at a time and to abandon any "free" situation, such as the living-cage, in which there would be unrestrained interaction among three or more animals simultaneously. (2) The simplest situation in which a choice method is used involves comparison of no more than two animals. Furthermore, choice of one of the stimulus animals by the test animal should result, so far as possible, in the temporary elimination of the other stimulus animal from the situation. It was also necessary to eliminate all social interaction between the two stimulus animals while in the experimental situation. (3) The situation had to allow approximately normal social behavior to occur between test animal and stimulus animal, and at the same time allow the observer to separate the animals conveniently in order to present the two stimulus animals to the test animal in a large number of preference trials. (4) It was highly desirable to construct the situation in such a way that the behavior of all three animals involved in a preference trial could be clearly observed and recorded.

The apparatus shown in figure 1 was used in the main part of the investigation. It consisted of a large cage (10 ft. long, 8 ft. wide, and 4 ft. high) divided into five sub-cages, each of which had approximately equal floor area. Each of the two *stimulus cages* contained one stimulus animal; each was insulated from the other by means of heavy wire netting, wall-board, and an inter-

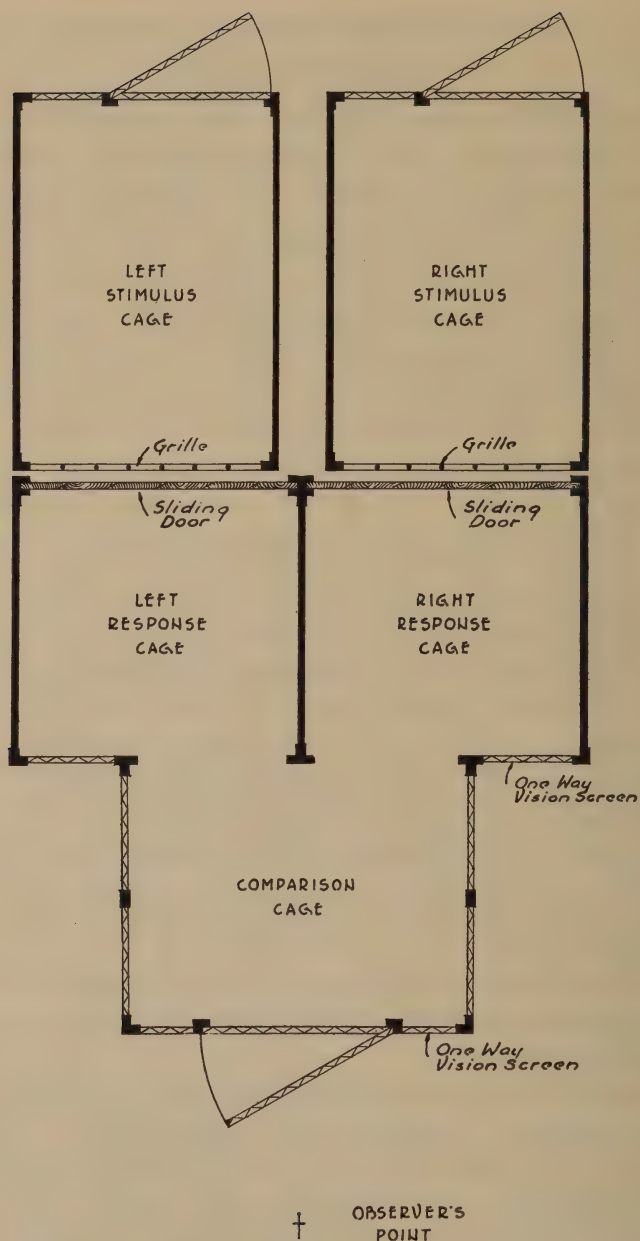


FIG. 1. FLOOR PLAN OF APPARATUS USED FOR TESTS OF COMPANIONSHIP PREFERENCE AND OF FOOD-SHARING

vening air space 10 in. wide. The other three cages were used by the test animal, which was trained to begin each trial in one, the *comparison cage*, from which it had a clear view of both stimulus cages. This cage afforded free access to the two *response cages*, each of which was adjacent to one of the stimulus cages. There was a wooden partition between the two response cages, and access to the one from the other could be attained only by passage through the comparison cage. The partition also served to prevent the test animal from responding simultaneously to both stimulus animals from either response cage. Between each response cage and the adjacent stimulus cage was a grille of heavy iron bars and a sliding door. The bars of the grille were spaced sufficiently far apart (4 in. on center) so that the animals could initiate and maintain many kinds of contact. Arms, legs, and face could easily be thrust between the bars. The sliding wooden doors were used to separate the test animal from the stimulus animals at the end of each trial. The cages were large enough to allow the occurrence of normally vigorous locomotor activity and withdrawal from contact with another animal. The observer watched through one-way vision screens placed at one end of the comparison and response cages and made the records in relatively low illumination. After the first few preliminary trials none of the animals appeared to respond to the presence of the observer during the three-minute preference trials.

After several different methods of testing companionship preference in this apparatus had been used in the preliminary work,² the method finally adopted was that of introducing the test animal to the cage with both sliding doors down, the stimulus ani-

² These attempts were based on the method of allowing the test animal to approach one of the two animals in each trial and to have contact only with this animal. Elimination by the experimenter of the second animal from the situation after the test animal had approached one was accomplished by lowering the adjacent sliding door. The lowering of the door usually instigated the test animal to reactions of fear and frustration and seriously changed its behavior with the one available animal. It was found that the lowering of both doors, with the resultant elimination of both animals, was followed only infrequently by such reactions.

mals having already been placed in the stimulus cages. The two doors were raised simultaneously by the observer and were kept up until the three-minute trial had ended, when they were lowered simultaneously. During the trial the test animal was free to go anywhere in the three units of the preference cage; that is, to either of the response cages or to the comparison cage. A record, by seconds, was made of the time which the animal spent in each of these three units. As will be described in section VI, this record also included the kind and duration of behavior exhibited. Length of each trial was set at three minutes because this seemed to be the minimum in which normal social behavior could be elicited over a series of trials.

In this method, the preferred animal of the stimulus pair in each three-minute trial was considered to be that one with which the test animal had spent the more time. In the first series, the time which a test animal spent with a given stimulus animal was taken to be exactly equal to the amount of time spent in the response cage adjacent to that stimulus animal. Thus the amount of time spent in the comparison cage, which was a very small percentage of the total, was not included. In the second series, a slightly different method was used. Time spent on one or the other side of the comparison cage was now included with the time spent in the immediately adjacent cage. This change was made because the behavior of the test animal while in the comparison cage often definitely involved one of the stimulus animals.

During the two series each animal was tested for its relative preference for each of the other four subjects. The testing procedure was as follows: The ten stimulus pairs which could be made up of the five members of the group were arranged in a balanced sequence of the kind described by Ross (1934). The sequences were also arranged so that a given stimulus animal occupied the two stimulus cages, left and right, an equal number of times during each of the two series. A pair of stimulus animals was placed in the stimulus cages for about an hour, during which each of the other three animals in turn chose between the members of the pair five successive times (5 three-minute trials).

In the second series, the number of successive trials was reduced to four. A fifteen-second interval separated the trials. The presentation of the entire sequence of ten pairs was repeated 4 times during the six weeks of the first series and 8 times during the eight weeks of the second series. Each animal was presented with each stimulus pair 20 times in the first series; for each animal there were six stimulus pairs and thus 120 trials in all. In the second series each animal had 32 trials with each stimulus pair, or 192 trials in all.

B. Results

Results of the first series of preference tests are presented in table 2. Columns 1 and 2 present the preferred and non-preferred animal in each of the six stimulus pairs of each test animal. The preferred animal is considered to be the one which was preferred in the larger proportion of 20 trials, as given in column 6. In one instance, two animals, Dick and Don, which were the least preferred of the group of four animals presented to Helene, were preferred in an equal proportion of trials (.50) in the series of 20 in which Helene chose between them. In this case the preferred status was given to Dick because of the greater amount of time (average of 86.45 seconds per trial) which Helene spent with him. Indeed, the values presented in columns 3 and 4, which represent the average time in seconds per three-minute trial which the test animal spent with each animal, provide an alternative criterion of preference. In every case the animal which received the larger amount of time per trial was also preferred in the larger proportion of trials, with the partial exception of the pair, Dick and Don, when presented to Helene, as has already been stated.

In using the proportion of trials (column 6) in which an animal was preferred in the total of 20 trials as a measure of preference, the significance of the measure can be obtained by computing the critical ratio of the proportion. In column 7 are presented the values of the critical ratios of the proportions in column 6; 16 of the proportions are large enough to yield critical ratios that exceed 2.5. In 16 of the 30 stimulus pairs, then, the preference

TABLE 2

Showing for each of five test animals the average amount of time spent with the preferred member (P) and the non-preferred member (N) of each of six stimulus pairs, and the percentage of trials in which P was the preferred member. First series

	1	2	3	4	5	6	7	8
TEST ANIMAL	STIMULUS PAIR		AV. NO. SECONDS IN 20 TRIALS			PROPORTION OF TRIALS IN WHICH P WAS PREFERRED	C.R. $p - .50$ sigma _p	PREFERENCE ORDER
	P	N	With P	With N	In comparison cage			
Dick	Rosy	Tom	163.95	16.05	0.00	.95	9.24	
	Rosy	Don	156.70	23.25	0.05	.90	5.96	1. Rosy
	Rosy	Helene	155.50	24.40	0.10	.85	4.38	2. Tom
	Tom	Don	158.80	21.15	0.05	.95	9.24	3. Don
	Tom	Helene	116.10	63.85	0.05	.80	3.35	4. Helene
	Don	Helene	86.65	82.10	1.25	.65	1.41	
Don	Rosy	Helene	113.40	59.20	7.40	.70	1.95	
	Rosy	Dick	144.00	32.80	3.20	.90	5.96	1. Rosy
	Rosy	Tom	125.70	47.25	7.05	.70	1.95	2. Helene
	Helene	Dick	107.60	63.45	8.95	.75	2.58	3. Dick
	Helene	Tom	135.00	38.65	6.35	.85	4.38	4. Tom
	Dick	Tom	87.95	79.85	12.20	.60	0.91	
Helene	Tom	Rosy	90.45	86.60	2.95	.60	0.91	
	Tom	Dick	126.00	49.30	4.70	.75	2.58	1. Tom
	Tom	Don	109.50	60.90	9.60	.70	1.95	2. Rosy
	Rosy	Dick	98.55	73.30	8.15	.55	0.45	3. Dick
	Rosy	Don	100.05	72.10	7.85	.55	0.45	4. Don
	Dick	Don	86.45	80.05	13.50	.50	0.00	
Rosy	Dick	Helene	172.10	7.10	0.80	1.00		
	Dick	Tom	141.75	33.80	4.45	.80	3.35	1. Dick
	Dick	Don	171.05	8.05	0.90	1.00		2. Helene
	Helene	Tom	124.70	51.40	3.90	.80	3.35	3. Tom
	Helene	Don	113.40	61.00	5.60	.70	1.95	4. Don
	Tom	Don	103.65	71.85	5.00	.60	0.91	
Tom	Helene	Dick	127.90	48.70	3.40	.80	3.35	
	Helene	Rosy	150.05	28.15	1.80	.85	4.38	1. Helene
	Helene	Don	156.50	17.60	5.90	.95	9.24	2. Dick
	Dick	Rosy	103.35	75.30	1.35	.55	0.45	3. Rosy
	Dick	Don	111.15	51.20	17.65	.65	1.41	4. Don
	Rosy	Don	100.90	55.25	23.85	.70	1.95	

for one animal over the other was definite enough to be indicated in a highly significant proportion of the 20 trials of the preference test.

In addition to the degree of preference exhibited for one animal in each of the stimulus pairs, the consistency of the preferences of the test animal for the four stimulus animals is also of interest. The data given in columns 1 and 2, showing the direction of the preference in each stimulus pair, can be treated with the test of consistency given by Woodworth (1938, p. 379). In the case of each test animal, all its preferences were perfectly consistent, i.e., one animal was preferred to the other three, the next preferred to all except the first, and the next preferred to the last only. By inspection it is clear that maximum consistency was exhibited, and t , the measure of consistency, has for each test animal its maximum value of 1. Young (1932) has found that the food preferences of the white rat are almost invariably characterized by a perfectly consistent preference order; he has called such orders examples of a "serial principle." Maslow (1933) found that the food preferences of certain infrahuman primates also fall in perfectly consistent orders. The appearance of perfectly consistent preferences in animal testing probably indicates not only that real preferences do exist, but also that irregularities which might have occurred through fatigue or temporary indifference on the part of the subjects, and through uncontrolled variations in the stimulus objects, have been cancelled out through repetition of the preference tests.

When preference tests are repeated, consistency of preferences may be indicated also by results which do not deviate from the expectation that preferences become more definite as animals in increasingly removed ranks in the preference order are compared. Thus, the most preferred animal in a preference rank should be preferred in an increasingly large proportion of trials as it is compared with animals of increasingly low preference rank. Both Young and Maslow found that consistency of this kind was not characteristic of the food preferences of their animal subjects. The chimpanzees used in this investigation exhibited this kind of consistency at least to a small degree. The data presented in

table 3 show for each test animal the average proportion of trials in which it preferred one animal to another in three types of stimulus pairs: (1) pairs composed of animals of adjacent rank in the preference order of the test animal, (2) pairs composed of animals once removed in the preference order, and (3) pairs composed of animals twice removed, the largest distance in an order of four items. For each test animal there were three pairs of the first type, two of the second, and one of the third type of stimulus pairs. The results for the first series indicate that two of the five test animals had increasingly large preferences as the rank distance between stimulus animals increased; none of the five showed a trend in the opposite direction. The mean results

TABLE 3

Showing for each test animal the average proportion of trials in which it preferred one animal (P) to another (N) in three types of stimulus pairs. First series

TEST ANIMAL	P AND N ADJACENT IN PREFERENCE ORDER	P AND N ONCE REMOVED IN PREFERENCE ORDER	P AND N TWICE REMOVED IN PREFERENCE ORDER
Dick	85.0	85.0	85.0
Don	68.3	87.5	70.0
Helene	55.0	65.0	70.0
Rosy	80.0	75.0	100.0
Tom	68.3	75.0	95.0
Mean.....	71.3	77.5	84.0

for the group also show a definite trend in the expected direction, although the differences between the means never attain statistical significance.

No attempt to measure the consistency among the preference orders of the five test animals will be made because of the incomparability of results obtained by using each judge as an object to be ranked by the other animal judges. It is interesting, however, to note the average rank of each of the animals (column 8, table 2) when the results of the five test animals are combined: Rosy, 1.75; Dick, 2.25; Helene and Tom (twins), 2.50 each; Don, 3.75. Rosy, with the lowest average rank, appears to be the most popular animal, and Don is easily the least popular.

The four sequences or repetitions of the testing of the prefer-

ences of the entire group of five animals in the first series occupied a six-week period. It is possible to find the preference order of each test animal in these four sequences by basing the computation of preferences on the results of 5 three-minute trials with each stimulus pair. A measure of the consistency among the

TABLE 4

Showing for each test animal the preference rank of four stimulus animals in each of four sequences of tests with a measure of consistency. First series

TEST ANIMAL	STIMULUS ANIMAL	RANK OF STIMULUS ANIMAL IN SEQUENCE				MEASURE OF CONSISTENCY
		1	2	3	4	
Dick	Rosy	2	1	1	1	SDmr 1.02
	Tom	1	2	2	2	SDn 1.12
	Don	4	3	3	3.5	t 0.91
	Helene	3	4	4	3.5	
Don	Rosy	1	1	1	1.5	SDmr 0.99
	Helene	2.5	2	2	1.5	SDn 1.12
	Dick	4	3	3	3	t 0.88
	Tom	2.5	4	4	4	
Helene	Tom	1	1	2	2	SDmr 0.73
	Rosy	4	2	2	1	SDn 1.12
	Dick	3	3	4	4	t 0.65
	Don	2	4	2	3	
Rosy	Dick	1	1	1	1	SDmr 1.06
	Helene	2	2	2	2	SDn 1.12
	Don	4	3	3.5	3	t 0.95
	Tom	3	4	3.5	4	
Tom	Helene	1	1	1	1	SDmr 0.93
	Dick	3	3	2	3	SDn 1.12
	Rosy	4	2	3	2	t 0.82
	Don	2	4	4	4	

four preference orders of the test animals obtained in this way will also indicate the consistency of the preferences through the six-week period. In table 4 is given the rank of each stimulus animal in the four sequences. Also given are the values of t as a measure of the general agreement among the rankings of each test animal from sequence to sequence. The method of

computing this measure of agreement is given by Woodworth (1938, p. 372 ff.). A t value of 1.00 represents perfect agreement, and a value of 0.00 represents the least possible agreement. The t values of all the animals except Helene are very large, and they indicate that highly stable preferences were exhibited by four animals throughout the six weeks of the first series of tests. The relatively low t value for Helene (0.65) is consistent with the fact that she was the only animal which exhibited a definite preferential change, for Rosy advanced from least preferred animal in Helene's preference order to most preferred during the six weeks of the first series of tests.

The results of the first series suggested that the reliability of the measure of preference in each stimulus pair could be increased by increasing the number of preference trials. An attempt to do this by limiting each trial to one minute was quickly ended because of the marked reduction in the relative amount of social behavior during each trial. In the fourth and final period of the investigation the second series of three-minute preference trials was made with four animals of the previous group in addition to Gamma, who replaced Rosy. The preference orders for each of the four animals used in both series have not been combined because of the radical change in living conditions, from continuous isolation to isolation during the day alone, and the marked resultant changes in social behavior. These changes will be discussed in section VI.

Table 5 presents results of the second series and corresponds to table 2 of the first series. In spite of the increase in the number of trials from 20 to 32 for each stimulus pair, the preferences are less definite in this series and the proportions as given in column 5 are, on the whole, smaller than the corresponding proportions of the first series. In only 8 of the 30 stimulus pairs was the preference for one animal over the other definite enough to be indicated in a significant proportion of the 32 trials, when a critical ratio of 2.5 or more is used as criterion. Nevertheless, each test animal again showed a perfectly consistent preference order. Consistency in preferences is also shown in the increase in preference when animals in increasingly distant ranks in the

TABLE 5

Showing for each of five test animals the average amount of time spent with the preferred member (P) and with the non-preferred member (N) of each of six stimulus pairs, and the percentage of trials in which P was the preferred member. Second series

	1	2	3	4	5	6	7
TEST ANIMAL	STIMULUS PAIR		AV. NO. SECONDS IN 32 TRIALS		PROPORTION OF TRIALS IN WHICH P WAS PREFERRED	C.R. $\frac{p-.50}{\sigma_p}$	PREFERENCE ORDER
	P	N	With P	With N			
Dick	Don	Tom	100.75	79.25	.69	2.32	
	Don	Gamma	102.84	77.16	.69	2.32	1. Don
	Don	Helene	111.90	68.10	.78	3.82	2. Tom
	Tom	Gamma	95.37	84.63	.56	0.68	3. Gamma
	Tom	Helene	113.46	66.54	.81	4.47	4. Helene
	Gamma	Helene	110.34	69.66	.81	4.47	
Don	Helene	Gamma	93.56	86.44	.59	1.04	
	Helene	Tom	113.81	66.19	.72	2.77	1. Helene
	Helene	Dick	93.78	86.22	.53	0.34	2. Gamma
	Gamma	Tom	101.03	78.97	.56	0.68	3. Tom
	Gamma	Dick	103.31	76.69	.63	1.52	4. Dick
	Tom	Dick	90.81	89.19	.53	0.34	
Gamma	Don	Dick	119.75	60.25	.72	2.77	
	Don	Helene	105.31	74.69	.56	0.68	1. Don
	Don	Tom	115.62	64.38	.66	1.91	2. Dick
	Dick	Helene	122.81	57.19	.66	1.91	3. Helene
	Dick	Tom	121.59	58.41	.63	1.52	4. Tom
	Helene	Tom	94.21	85.79	.50	0.00	
Helene	Tom	Gamma	91.63	89.37	.53	0.34	
	Tom	Dick	100.93	79.07	.75	3.27	1. Tom
	Tom	Don	117.93	62.07	.75	3.27	2. Gamma
	Gamma	Dick	85.88	94.12	.56	0.68	3. Dick
	Gamma	Don	97.09	82.91	.59	1.04	4. Don
	Dick	Don	103.81	76.19	.59	1.04	
Tom	Dick	Helene	104.15	75.85	.53	0.34	
	Dick	Gamma	105.96	74.04	.59	1.04	1. Dick
	Dick	Don	117.84	62.16	.69	2.32	2. Helene
	Helene	Gamma	116.71	63.29	.72	2.77	3. Gamma
	Helene	Don	102.87	77.13	.53	0.34	4. Don
	Gamma	Don	115.12	64.88	.66	1.91	

preference order are compared. This is indicated in table 6 in which the results of two of the five animals and the mean results of the entire group show this trend without any reversals.

There is also a decrease in the measures of the general agreement among the rankings of each of the test animals through the eight sequences of this second series, as shown in table 7. Dick is the only animal with a high t value (0.78) in this series. The comparatively low consistency of the other animals appears to be based on no definite preferential changes for particular animals, but is simply a result of the irregular variation of preference from week to week.

TABLE 6

Showing for each test animal the average proportion of trials in which it preferred one animal (P) to another (N) in three types of stimulus pairs. Second series

TEST ANIMAL	P AND N ADJACENT IN PREFERENCE ORDER	P AND N ONCE REMOVED IN PREFERENCE ORDER	P AND N TWICE REMOVED IN PREFERENCE ORDER
Dick	68.7	75.0	78.0
Don	56.0	67.5	53.0
Gamma	62.7	59.5	66.0
Helene	56.0	67.0	75.0
Tom	63.7	56.0	69.0
Mean	61.4	65.0	68.2

These results indicate that definite preferences were exhibited by all the test animals in both series of tests in the experimental situation. These preferences were shown sufficiently frequently toward members of some of the stimulus pairs (16 pairs in the first series and 8 pairs in the second series) to be considered statistically significant when series of tests of only 20 and of 32 trials were used. Moreover, the preference order of each test animal is perfectly consistent when the results of an entire series of tests are considered. The consistency of the ratings of each of four of the five test animals from week to week was very high during the first series, but only one animal exhibited high consistency of this kind in the second series. It is interesting to note that while the animals showed agreement with each other in prefer-

ence rankings in the first series, at least to the extent of establishing a most preferred animal, Rosy (average rank 1.75), and a least preferred animal, Don (average rank 3.75), there was complete disagreement in the rankings of the second series, and each stimulus animal received exactly the same average rank (2.50)

TABLE 7

Showing for each test animal the preference rank of four stimulus animals in each of eight sequences of tests with a measure of consistency. Second series

TEST ANIMAL	STIMULUS ANIMAL	RANK OF STIMULUS ANIMAL IN SEQUENCE								MEASURE OF CONSISTENCY
		1	2	3	4	5	6	7	8	
Dick	Don	1	1	2	4	1	1.5	1	1	SDmr .87 SDn 1.12 t .78
	Tom	2	2	3	2	3	1.5	2	2.5	
	Gamma	4	3	1	1	2	3	3	2.5	
	Helene	3	4	4	3	4	4	4	4	
Don	Helene	1	3	2	1	4	2	1	1	SDmr .47 SDn 1.12 t .42
	Gamma	2.5	1.5	3.5	2	3	1	2	2.5	
	Tom	2.5	1.5	3.5	4	2	3	4	4	
	Dick	4	4	1	3	1	4	3	2.5	
Gamma	Don	2	3	2.5	3	2	1	1	1	SDmr .44 SDn 1.12 t .39
	Dick	4	2	1	1	4	2	2	2	
	Helene	3	1	2.5	4	3	3.5	3	3	
	Tom	1	4	4	2	1	3.5	4	4	
Helene	Tom	1	2	4	1.5	3	1	1	1	SDmr .59 SDn 1.12 t .53
	Gamma	2.5	1	1	4	1.5	2	3	2	
	Dick	4	3	2.5	1.5	1.5	4	2	4	
	Don	2.5	4	2.5	3	4	3	4	3	
Tom	Dick	4	2	1	1	1	2	2	1.5	SDmr .41 SDn 1.12 t .37
	Helene	1	3	4	2	2	3.5	1	4	
	Gamma	3	1	3	3	3	3.5	3	3	
	Don	2	4	2	4	4	1	4	1.5	

when the rankings of all five test animals were combined. The change in living conditions between the first and second series, from complete isolation to isolation during the day only, had a definite effect on the social behavior and the preferences exhibited in the experimental situation. This will be discussed in the analysis of behavior, section VI.

IV. TESTS OF DOMINANCE STATUS

A. Procedure and apparatus

In his extensive survey of the recent literature on the social psychology of the vertebrates, Crawford (1939, p. 418) has pointed out that although superiority in fighting ability is a widely used criterion of dominance status, "it is often impractical to observe all the fighting which may take place within a group of animals under observation, so that in certain investigations relative dominance status has been inferred from other behavioral indices or indirect measures adapted to the peculiarities of the species." The use of other criteria of dominance status is particularly necessary in the measurement of dominance status in the chimpanzee, not only because fighting behavior occurs relatively infrequently in groups of captive chimpanzees in which relatively stable social habits have been established, but also because subtle and complex behavior, other than fighting, often appears to determine the ascendancy of one animal over another in a competitive situation. As a working definition of dominance in experimentally induced competition, Yerkes has used the following (1939, p. 119): "Dominance implies simply priority of response and ability to delay or inhibit the response of a companion." The only criterion of dominance used in the present tests was priority of response in two competitive situations in which two animals at a time were involved, called food tests and escape tests.

A small cage (5 x 3 x 4 feet) was firmly fixed on top of a table 2½ feet high. A horizontal partition of wood divided the entire cage into two levels. A small opening in this partition could be closed with a sliding door. Extending out from the bottom chamber of the cage was a narrow trough, 6 feet long, through which the observer could push peanut kernels to the subjects. When two animals were in the bottom chamber they could see the food as it approached but could not reach it until it had been pushed into the cage. This procedure allowed conflict and adaptation to occur between the two before the food was within reach. Usually one of the animals had complete possession of

the position immediately in front of the trough by the time the food arrived.

The animals were also trained individually to leave the cage by climbing into the top chamber through the small opening in the horizontal partition and to wait there a few seconds for the opening of a second door in the chamber. When two animals were present, the first one to climb through the opening into the top chamber after the small sliding door had been opened was soon thereafter taken to its living quarters. By closing the sliding door, the observer prevented the other animal from climbing into the top chamber while the first animal was still there. The brief period of isolation in a small elevated cage, in a relatively unfamiliar room, which followed the departure of the observer with the successful animal, probably constituted minor punishment for the lone animal. After a few training trials each of the animals, when alone in the cage, climbed hurriedly into the top chamber as soon as opportunity to do so was presented. When two animals were in the bottom chamber, rather intense conflict, lasting a few seconds, often occurred when the sliding door was opened, or sometimes as soon as the observer approached the handle which controlled the door.

An experimental session was given to every pair once a week which consisted of three brief trials, two involving food-competition and one involving escape-competition. The two animals were placed in the bottom chamber, and after a brief pause the first trial was given. This consisted in pushing 10 peanut kernels along the trough at the rate of one every 10 seconds. A record was kept of the number of kernels which each animal took. The second trial followed the first after a brief pause and consisted in pushing 20 kernels of peanut all at once through the trough to the cage. Conflict occurred more frequently in the second trial than in the first. A record was made of the number of kernels taken by each animal. A third trial completed the session and allowed one of the animals to escape from the situation. A record was made of the animal which succeeded in escaping first. After all ten pairs of animals had had four preliminary sessions, they were tested thus once a week during the

eight weeks of the second series of preference tests. Each pair was used in 8 preliminary and 16 regular food trials; in 4 preliminary and 8 regular escape trials.

B. Results

These tests yielded measures of dominance status in terms of rank in the group of five. It was easy not only to observe and determine the relative dominance status in each of the ten pairs tested, but also to ascertain that for this homogeneous group of young animals, each thoroughly familiar with the others in the

TABLE 8

Showing the number of trials in which each member of each pair (a) took all or most of the food, (b) escaped from the situation first in tests of dominance status

PAIR	NO. TRIALS IN WHICH ANIMAL LISTED ON LEFT OBTAINED ALL OR MOST OF FOOD		PAIR	NO. TRIALS IN WHICH ANIMAL LISTED ON LEFT ESCAPED FIRST	
	Prelim. trials Max. N = 8	Regular trials Max. N = 16		Prelim. trials Max. N = 4	Regular trials Max. N = 8
Tom-Dick	8	16	Tom-Dick	0	5
Tom-Helene	8	16	Tom-Helene	1	8
Tom-Don	8	16	Tom-Don	0	4
Tom-Gamma	8	16	Tom-Gamma	1	8
Dick-Helene	2	13	Dick-Helene	3	8
Dick-Don	8	16	Dick-Don	0	6
Dick-Gamma	8	16	Dick-Gamma	3	8
Helene-Don	8	16	Helene-Don	3	4
Helene-Gamma	8	16	Helene-Gamma	4	8
Don-Gamma	7	14	Don-Gamma	3	8

group, there existed a hierarchical order of dominance of the type observed in other vertebrates. Table 8 presents the number of trials, in both the regular and preliminary sessions, in which each animal took all or most of the food and in which each escaped first. The members of each of the ten pairs are presented with the animal which was the more dominant in the regular trials listed first. Stable dominance relations were exhibited in the food tests from the very beginning, except in the case of Dick and Helene. Dick did not take much of the food until the third

preliminary session, but from then on he did so regularly. The complete dominance of Tom in the food test was never challenged by any of the other animals, and no animal ever attempted to take any food when he was in the cage. The control which Dick exercised over the three animals subordinate to him was also nearly complete. When one of these three animals took a kernel or attempted to do so, Dick became vigorously aggressive toward it, except occasionally when paired with Helene. Gamma was completely subordinate in the situation. On the few occasions in which she did obtain a kernel, even her chewing seemed to be inhibited by the competitive situation or by the presence of a dominant animal, for it was unusually slow. The dominance order of the animals in the food competition test was clearly and definitely Tom first, then Dick, Helene, Don, and Gamma.

In the first preliminary session the results of the escape tests showed that in only three of the ten pairs did the animal which had secured most of the food also escape first. Priority in food competition implied, if anything, lack of priority in escape in this session. At least three factors can be recognized which help to explain this inconsistency. (1) We may assume that the food-expectancy of the animal which had obtained all or most of the food was stronger than that of the animal which had obtained a relatively small share of the food or none at all. Food-expectancy conflicted with escape activity. (2) Furthermore, competition for food was a familiar experience for these animals. (3) On the other hand, competition for priority in escape from a relatively unpleasant situation rarely occurs in their normal activities; indeed, escape from an unpleasant situation would usually elicit in these immature animals a kind of coöperative activity in which the pair, in intimate contact with each other, made their egress together. Thus each animal in the escape tests had to learn that it would be isolated for an interval if it did not succeed in climbing into the upper chamber before its companion did. That the subjects did learn to adapt more precisely to the temporal limits of the food situation, or to the punishment of isolation which followed the removal of the escaped companion, or to both, is demonstrated in the following

data: The number of pairs out of the total of ten in which the subject which obtained food first also escaped first was 3, 4, 4, and 6 respectively in the four preliminary sessions, and 8, 9, 7, 8, 9, 9, 9, 8 in the eight regular sessions. After the period of learning and adaptation in the four preliminary sessions, each animal adapted to the same stable dominance relations which were exhibited in the food-competition tests, and the dominance order in the regular series of escape tests thus became practically identical with that exhibited in the food tests.

Irregularities appeared in Don's behavior. He was normally motivated in the food competition, but was much more highly motivated to escape from the situation than were the other four animals. Don's record as experimental subject in the laboratory includes an unusually large number of instances in which he refused for long periods of time to enter a solitary confinement cage. His high motivation for escape from the present situation is clearly related to this strong and persistent aversion to isolation. His vigorous striving for priority of escape resulted in his unexpected success in doing so as often as Tom or Helene did when he was paired with either of them. Don must be rated as at least equal to Helene with respect to dominance in competition for priority of escape.

When the animals are listed according to average rank in both food test and escape test, the dominance order is Tom first, Dick, Helene, Don, and Gamma.

V. FOOD-SHARING TESTS

A. The problem

The study of Nissen and Crawford (1936) demonstrated that food-sharing between two young individuals was not an unusual pattern in chimpanzee social behavior and that it could be elicited in an experimental situation in which two animals were separated by a grille. They found that transfer of food from one to another animal occurred in any one of three clearly defined patterns: (1) independent acquisition, in which the subject without food reached into the other cage and picked food from the floor; (2) unsolicited passing, in which the animal with food gave some

to the other without any preceding effort on the part of the latter to acquire food; and (3) begging, in which the animal without food extended its arm into the other cage, often flexed its hands and fingers rapidly, sometimes vocalized with whimpers, whines, or screams, or stomped vigorously and violently shook the grille between the two cages. It is clear from their description that begging sometimes appeared to be a kind of demanding. They report, in fact, that mock-attacks were not uncommon when the two animals were antagonistic or non-friendly. The frequency of begging and positive response to begging, however, was greater "between animals who had previously established a close friendship than among those not intimate with each other" (p. 417). They suggest, in discussing the behavioral factors involved in food-sharing, that the giving of food to a begging animal may be a response which "gets rid of the presumably unpleasant stimulus of begging by the partner" (p. 416).

The observations and analysis of food-sharing by Nissen and Crawford pose a number of problems which form an excellent opportunity for use of the methodology referred to in the introduction of the present paper: the measurement in independent tests of the two variables, preference and dominance, and the controlled use of these variables in the analysis of a particular social interaction, in this case food-sharing. How does food-sharing (its quantity and the behavior mechanisms involved) vary with preference status and dominance status?

B. Procedure

At the end of each session of four preference trials throughout the second series, each test animal was given 20 kernels of peanut in the comparison cage. The two doors in front of the two stimulus animals were not lowered at the end of the fourth trial, so that the test animal was free to approach either of the animals and to share food with it or to stay in the comparison cage, out of reach of the other two, and eat all the food there. The length of the food trial was limited to three minutes, but the food was usually completely consumed within one minute. A record was made of the frequency and type both of food-transfer to and of

solicitation by the stimulus animals, and the places occupied by the test animal while eating.

Each stimulus animal was presented to each test animal in three different pairs and these presentations were repeated in each of the eight sequences of tests in the second series; a test animal therefore had 24 opportunities to share food with each of the four stimulus animals. For the entire group there were, in 240 trials, 480 opportunities to share food with a partner. The opportunities were twice the trials in number because two stimulus animals without food were present in each trial.

C. Results

Food-sharing was observed in 80 of the 480 occasions. In every one of these 80 instances the food transfer was from a subordinate animal to a dominant animal. A dominant animal never shared food with a subordinate partner.

The results presented in tables 9 and 10 are arranged to show the pairs and the direction in which food-sharing took place. In table 9 the animals without food are arranged under each test animal in order of relative preference status and in table 10 in order of relative dominance status. The results indicate that there is no relation between food-sharing and preference,³ but that the relation between food-sharing and dominance status is very definite. Tom and Dick, the two most dominant animals, received between them 73 per cent of the food shared, and Don and Gamma, the two most subordinate subjects, together gave 76 per cent of the food shared. Tom never shared food, and Dick shared on only four occasions, all of these with Tom. Food was never shared with Gamma, and Don received food only five times, all of these from Gamma.

The behavior of all the subjects without food varied from complete indifference during a single trial to violent excitement. Between these extremes the behavior of the stimulus animal with respect to the test animal with food included the following pat-

³ The subjects in the present study were all thoroughly familiar with each other. For the relation between frequency of sharing and degree of familiarity of partner, see Nissen and Crawford (1936, p. 417).

terns: (1) quiet watching of the other's eating; (2) very intense watching, with lip and mouth movements, perhaps a form of empathy; (3) excited and undirected activity in the form of rapid, rotating locomotion, or of falling on the back with flailing of the arms and legs, probably an incipient temper tantrum; (4) gentle begging, with extension of the arm and flexions of the hand and

TABLE 9

Showing the number of occurrences of food-sharing between a test animal with food and each of four stimulus animals, presented in order of preference

	TEST ANIMAL WITH FOOD							
	Tom	Dick	Helene	Don	Gamma	TOTAL		
Stimulus animals in order of preference	(1) Dick 0	Don 0	Tom 7	Helene 11	Dick 9	27		
	(2) Helene 0	Tom 4	Gamma 0	Gamma 0	Don 5	9		
	(3) Gamma 0	Gamma 0	Dick 8	Tom 10	Helene 6	24		
	(4) Don 0	Helene 0	Don 0	Dick 12	Tom 8	20		
Totals.....	0	4	15	33	28	80		

TABLE 10

Showing the number of occurrences of food-sharing between a test animal with food and each of four stimulus animals, presented in order of dominance

STIMULUS ANIMALS IN ORDER OF DOMINANCE	TEST ANIMAL WITH FOOD					TOTAL
	Tom	Dick	Helene	Don	Gamma	
Tom		4	7	10	8	29
Dick	0		8	12	9	29
Helene	0	0		11	6	17
Don	0	0	0		5	5
Gamma	0	0	0	0		0
Totals.....	0	4	15	33	28	80

fingers, and characteristic vocalization; (5) aggressive begging or demanding, with stomping, lunging, and shaking of the cage and grille. One or both of the latter two patterns, which included all instances of solicitation, occurred in 50 (10 per cent) of the 480 occasions, and were apparently entirely ignored in 16 (32 per cent) of the instances by the animal with food.

Each of the subjects, except Gamma and Tom, typically took

food in its hands and mouth from the floor of the comparison cage and approached one of the stimulus animals, or both in succession. These approaches were observed in 212 of the 480 occasions, in 34 when the other was soliciting, and in 178 when the other was not. When at the grille with food a subject either passed some directly to the other (39 instances) or allowed the other animal to take food from its mouth or hand (41 instances), or succeeded in eating all the food without sharing any of it (132 instances). Tom invariably ignored the stimulus animals and ate all his food in the comparison cage (48 instances); the other four subjects ate in the comparison cage in only 56 instances. Gamma differed from the others because of her frequent failure to pick up and eat all the food. The types of interaction observed thus include the following: the subject with food may (1) eat in the comparison cage, (2) approach with food and share none with an animal which is either soliciting or not, or (3) approach with food and share it with a soliciting or non-soliciting animal.

All forms of interaction, except that of eating food in the comparison cage, which represents absence of interaction, decreased as the tests were repeated during the eight weeks. There were 49 instances of food-sharing in the first half of the series and 31 in the second half. There were in the first half 120 approaches with food to the other animals, and only 92 in the second. The frequency of soliciting decreased from 31 in the first half to 19 in the second. The frequency of eating in the comparison cage increased from 47 in the first half to 57 in the second.

These questions now arise. What is the relative effectiveness of dominant and subordinate status in activating another animal to approach with food and also to share food? Also, what is the relative effectiveness of soliciting behavior and non-soliciting behavior in eliciting approach with food and food-sharing?

Of the 50 instances in which the test animal solicited, the animal with food approached in 34 (68 per cent) and shared food in 24 (48 per cent). In the 430 instances in which the other did not solicit, the animal with food approached in 178 (41 per cent) and shared food in 56 (13 per cent). Thus soliciting is more effective than quiet behavior in both these respects.

In the 240 instances in which a dominant animal was present as stimulus animal, the test animal with food approached in 116 (48 per cent) and shared food in 80 (33 per cent). In the other 240 instances, when the other was subordinate, the animal with food approached in only 96 (40 per cent) and never shared food. Dominant animals were, therefore, more successful than subordinate animals in activating the test animal both to approach with food and to share it.

TABLE 11
Showing the proportion of occasions on which stimulus animals, dominant and subordinate, soliciting and non-soliciting, (a) were approached by the test animal with food, and (b) received food from the test animal

	CHARACTERISTICS OF STIMULUS ANIMAL WITHOUT FOOD			
	Dominant and soliciting	Dominant and non-soliciting	Subordinate and soliciting	Subordinate and non-soliciting
Test animal approaches with food				
1st four weeks.....	.76	.51	.50	.43
2d four weeks.....	.61	.36	0	.37
Total period.....	.70	.43	.33	.40
Test animal shares food				
1st four weeks.....	.55	.40	0	0
2d four weeks.....	.44	.21	0	0
Total period.....	.51	.29	0	0
No. of occasions.....	47	193	3	237

The 480 occasions for food-sharing may be placed in four classes on the basis of the behavior and dominance status of the animal without food: (1) dominant animal solicits; (2) dominant animal does not solicit; (3) subordinate animal solicits; (4) subordinate animal does not solicit. The relative effectiveness of each of these classes is shown in table 11. The most successful combination is that of dominance status and soliciting behavior. Of the 47 occasions in which a dominant animal begged for food, the partner approached with food in 70 per cent and shared food in 51 per cent. The non-soliciting dominant subject is less

effective in influencing the partner to approach (43 per cent) and to share (29 per cent). The subordinate animal, whether soliciting or not, is still less successful in influencing the partner to approach and never succeeds in getting food from the partner. The results as presented have also been divided into those of the first half and those of the second half of the series of tests. All of these combinations were less effective in the second half than in the first.

D. Discussion

That the chimpanzee is capable of social instrumentation and of using a partner as a means for securing goal-objects has been demonstrated many times in the research of this laboratory. The work of Crawford (1937, 1940) on coöperation, for example, has been specifically directed at the study of the gestures which the chimpanzee uses in social interaction of this type. The present study demonstrates that both dominance status and soliciting behavior are determining factors in the success which one animal has in influencing another. In the food-sharing situation only dominant animals succeeded in having food shared with them. Dominant animals were more successful also in instigating partners to approach with food. Success in achieving this latter end was more frequent for both dominant and subordinate animals when they solicited for the unavailable food.

The effectiveness of dominance status and soliciting behavior in this interaction suggests a mechanism by which the act of sharing food is reinforced. In some of the previous situations in which unpossessed food was available, the familiar dominant partner both approached the food and influenced the behavior of the other through threatened or inflicted aggressive behavior. In the experimental food-sharing situation the elements of loose food and striving dominant partner again appear and probably serve as excitement- or anxiety-arousing stimuli because of their function as signals of punishment. The situation thus presents to the subordinate animal with food the problem of performing an act which will reduce anxiety through termination of the disturbing stimuli. This act will be reinforced because of the

reinforcing rôle of reduction of anxiety or excitement (McCulloch, 1939; Mowrer, 1939). The successful instrumental acts exhibited by every subordinate partner were those of terminating the striving of the dominant animal either by approaching it with food or by both approaching and giving it food.

VI. ANALYSIS OF BEHAVIOR

A. The data

The 600 three-minute preference trials of the first series and the 960 preference trials of the second series afforded an opportunity to make a large number of records of the social and non-social behavior of the young chimpanzee. During the first series the five animals were completely isolated from each other except when they were in the preference apparatus. Over a period of six weeks all their social behavior with each other, excluding brief casual contacts, occurred during these 600 trials. Over a period of eight weeks in which the 960 trials of the second series were presented, the animals were caged together at night and isolated during the day except during the hours of experimentation. The average period of isolation per day per subject was approximately 23 hours during the first series and 8 hours during the second. As will be described below, it was possible to record the type and duration of the behavior of the test animal in all these trials, and also to make in all trials a practically complete record of the social behavior of the stimulus animal while the test animal remained with it. Furthermore, during the second series the subjects were placed, two at a time, in a detention cage in which there was no barrier between the partners. Each pair of animals was observed every other week in this no-barrier situation during a session of 21 minutes consisting of four successive three-minute periods separated by intervals of three minutes. During the eight weeks 16 observations were made on each of the ten pairs. A total of 1720 three-minute records of behavior was made during the two series of preference trials and the observations in the no-barrier situation.

B. Method of recording

The method of recording used here was essentially the same as that developed by Washburn (1932), and used by Washburn and Hilgard (1934) and by Swan (1938). A metronome set at 60 beats per minute was used to supply audible time signals. As each beat was heard, the observer made a short vertical line on a sheet of paper fixed in a lap board. As changes in the position and the behavior of the animal occurred, appropriate symbols were added to the record. A stop watch was in clear view at all times. Observation and record began in each trial as soon as the doors, which permitted the test animal to have access to the stimulus animals, were raised. After 180 seconds, the trial was ended, the record complete, and the doors were lowered.

Each three-minute record supplied the following information: (1) the length of time in seconds spent by the test animal in each of the three units of the preference apparatus; (2) the presence or absence during the entire trial of each of a number of categories of behavior; (3) the duration of each type of behavior as it occurred during the trials. Two measures of each type of behavior were thus available: (1) the *frequency* of the behavior, in terms of the number of three-minute periods in which it occurred; and (2) the *duration* of the behavior, in terms of the number of second-notations made from the second of its appearance to the second in which another type of behavior appeared.

C. The categories of behavior

The following classification of behavior was adopted after considerable practice in observing and recording the social activity of young chimpanzees. Following the studies of Barker (1930), Arrington (1932), and Thomas, Loomis, and Arrington (1933) on very young children and adult human beings, the behavior was classed in pairs of mutually exclusive categories; that is, in such a way that only one member of each pair could appear simultaneously. The task of finding mutually exclusive categories was relatively simple because the situations were arranged

so as to allow each animal to approach and respond to only one other animal at a time, and also to allow meager opportunity for activity with non-social materials.

The basic dichotomy was that of social versus non-social behavior. Social behavior included all observable responses directed toward another animal. The activity of watching another animal engage in non-social behavior was recorded as a separate category (no. 13) and is not included in the following analysis. All other behavior was considered non-social. Two sub-dichotomies were used in the classification of social behavior: (1) behavior involving physical contact with another and behavior involving no contact; (2) behavior which included aggressive characteristics and behavior which did not include aggressive characteristics. This latter classification was based on the following definition: the hostile fighting which sometimes occurs among young chimpanzees was not observed in these situations. Many of the same behavior elements, however, such as slapping, biting, and grappling, which characterize serious fighting, occurred in the activity exhibited here. Behavior including these elements was easily recognized and was quite readily distinguished from that which did not include them. The former behavior has been arbitrarily called "aggressive" and the latter "non-aggressive."

This classification yielded the following four categories of social behavior: (1) non-aggressive without contact; (2) non-aggressive with contact; (3) aggressive without contact; (4) aggressive with contact. Included in the record also was the direction of the behavior, that is, whether the test animal alone or the stimulus animal alone was active, or whether both animals were simultaneously actively engaged in the social behavior. The four categories could occur under any one of these three conditions, and it was necessary to use twelve rather than four categories, as shown in table 12.

A very large portion (87 per cent) of the social behavior occurred in the form of two distinct patterns, grooming and play-fighting. The grooming pattern, carefully described elsewhere (Yerkes, 1933), consists chiefly in the examination, visual and

TABLE 12
Behavior classification

-
- I. Social
 - A. Initiated and maintained by test animal toward socially inactive stimulus animal
 - Category 1. Non-aggressive without contact
Presenting, soliciting
 - Category 2. Non-aggressive with contact
Grooming
 - Category 3. Aggressive without contact
Stomping, lunging, etc.
 - Category 4. Aggressive with contact
Mauling
 - B. Initiated and maintained by both animals
 - Category 5. Non-aggressive without contact
 - Category 6. Non-aggressive with contact
Tandem sitting, sexual behavior, mutually active grooming
 - Category 7. Aggressive without contact
Mutual stomping, lunging; play-fighting
 - Category 8. Aggressive with contact
Wrestling; play-fighting
 - C. Initiated and maintained by stimulus animal toward socially inactive test animal
 - Category 9. Non-aggressive without contact
 - Category 10. Non-aggressive with contact
 - Category 11. Aggressive without contact
 - Category 12. Aggressive with contact
 - II. Observant behavior (test animal only)
 - Category 13. Test animal quietly watches stimulus animal engaged in non-social activity
 - III. Non-social (test animal only)
 - A. Material behavior
 - Category 14. Examination, manipulation, chewing of material object
 - B. Self-directed behavior
 - Category 15. Non-social locomotion
Somersaulting, violent locomotive activity
 - Category 16. Behavior directed toward animal's own body
Self-grooming, scratching, etc.
 - C. No overt activity
 - Category 17.

Summary

Social behavior includes categories 1-12

Contact social behavior includes categories 2, 4, 6, 8, 10, and 12

Non-contact social behavior includes categories 1, 3, 5, 7, 9, and 11

Aggressive social behavior includes categories 3, 4, 7, 8, 11, and 12

Non-aggressive social behavior includes categories 1, 2, 5, 6, 9, and 10

oral, and manipulation, manual and oral, of the hair, skin, and bodily orifices of the self or partner, usually accompanied by characteristic accessory lip, hand, or foot movements. In the adult chimpanzee, mutual grooming, in which both partners simultaneously explore the coat and skin of the other, is frequently observed. This pattern was extremely rare in the present young subjects; the usual pattern involved complete relaxation by the animal being groomed. Of the hundreds of instances of grooming observed, the few which showed mutual activity were placed in category 6; all others were placed in categories 2 and 10, which together supply a good measure of grooming activity because no other pattern was included in these.

The play-fighting pattern, also described elsewhere (Nissen, 1931, p. 81), consists chiefly in the simultaneous aggressive behavior of two animals toward each other. It involves lunging and stomping, grappling and wrestling, mock-biting and grunting. Like grooming, this pattern sometimes becomes very intense and may continue in favorable circumstances for several minutes. Categories 7 and 8 include all these instances of mutual play-fighting and together supply a measure of this activity.

Sexual behavior in the testing situations was rarely observed in these pre-adolescent animals. Mating behavior was never observed. There was no mutual or auto-masturbation. When the subjects were introduced to the experimental situation they sometimes approached each other immediately and sat for a few seconds with arms around each other making thrusting movements with the pelvis; these occurrences are included in category 6. Elevation and presentation of the anal region to a partner occurred quite frequently and was followed by inspection and grooming or by indifference on the part of the partner. The act did not appear to have sexual significance in these subjects, for it had no evident relation to any other acts of the reproductive pattern. The act did appear to have importance as an initiator of grooming by the partner and was always recorded in category 1. Vocalizations of several kinds accompanied some of the listed categories of behavior, but they were not used as necessary criteria of any given category.

D. Reliability

The consistency of the data in terms of frequency was checked and found to be satisfactory with respect to the following: (1) the reliability of the device in the hands of the observer, (2) the reliability of the observer in recording the data, (3) the consistency of repeated observations on the same individual, and (4) the sensitivity of the method in differentiating individuals.⁴ Results in terms of duration of behavior are used only to supplement the frequency data, and no reliability measures of this aspect of the recording were made.

E. Results

As indicated in table 12 it was possible to classify the items of behavior in terms of seventeen categories,⁵ and thereafter in terms of main classes (social and non-social), sub-classes of social (contact, non-contact, aggressive, non-aggressive), and outstanding patterns (grooming and play-fighting). It was possible to classify the items also according to the three sets of alternative conditions in which they were exhibited: (1) behavior after 23 hours of isolation versus behavior after 8 hours isolation, (2) interaction of the test animal with the preferred member of the stimulus pair versus interaction with the non-preferred member, and (3) interaction of the test animal with the dominant member of the stimulus pair versus interaction with the subordinate. The relation of frequency of types of behavior to each of these paired conditions is now examined.

1. *Differences in behavior in the first and second series.* In table 13 is presented for the four subjects (Dick, Don, Helene, Tom) which were used in both series the mean frequency per ten trials of the types of behavior exhibited when they were test animals.⁶ The results indicate that all four subjects exhib-

⁴ For the tests of consistency see the dissertation on file in the Yale University Library.

⁵ For analysis of the data in terms of the seventeen categories, see dissertation, *op. cit.*

⁶ The mean frequencies of social and non-social behavior are presented in terms of every ten trials in which the test animal was presented with the stimulus animals. The mean frequencies of the other six types of behavior, all being sub-

ited social behavior more frequently in the first series than in the second; all four also exhibited contact, non-aggressive, and grooming behavior more frequently in the first series. Play-fighting, aggressive behavior, and non-social behavior were exhibited more frequently by all four subjects in the second series than in the first. When the data for each subject are examined, a measure of the reliability of the difference between the proportion of trials in which a type of behavior occurred in the first series and its proportion in the second series may be roughly estimated.⁷ Critical ratios computed by the following formula are presented in the last column of each of tables 13 to 15:

$$\text{Critical ratio} = (p_1 - p_2) / \sqrt{\text{sigma } p_1^2 + \text{sigma } p_2^2}$$

When the total data of the group are examined, several measures of the reliability of the difference between the mean frequencies of a type of behavior in the two series are available. Of these probably the most direct is a measure of the consistency among all subjects with respect to the sign of the difference. When the results of four subjects are used, as in table 13, the probability of all four showing a difference in the same direction for one type of behavior is 1 in 16 by chance. In the latter comparisons of this section, when the results of five animals are used, the probability of all five showing a difference in the same direction by chance is 1 in 32.

The data in terms of duration are summarized in table 16.⁸

types of social behavior, are presented in terms of every ten trials in which social behavior was observed. These two definitions of mean frequency are used for the data in tables 13 to 15.

⁷ The conditions of simple sampling (Yule, 1936, p. 261) were not fulfilled in this situation, but were approximated. Of special importance in this approximation was the high degree to which the occurrence of a behavior item of one class remained independent of the occurrence of an item of another class, because of the relatively great length of the period as compared with the duration of an item, and because of the possible contribution of an item by any one of three animals in each period.

⁸ Mean seconds per minute values for social and non-social behavior were computed in terms of each minute the test animal spent with the stimulus animal. Mean seconds per minute values for the other six types of behavior were computed in terms of each minute of social behavior exhibited by the two animals. These mean values correspond to those used for the data in terms of frequency, tables 13-15.

TABLE 13

Showing the mean frequency per ten trials of classes of behavior observed. First and second series

BEHAVIOR CLASS	TEST ANIMAL	MEAN FREQUENCY PER TEN TRIALS		DIFF. (1st - 2d)	C.R.
		1st series	2d series		
Social (Categories 1-12)*	Dick	10.00	9.64	+0.36	2.66
	Don	9.59	7.97	+1.62	4.87
	Helene	8.75	5.93	+2.82	6.02
	Tom	8.33	7.35	+0.98	1.92
	Group	9.17	7.72		
Non-social (14-17)	Dick	7.92	10.00	-2.08	5.62
	Don	9.75	9.77	-0.02	0.12
	Helene	9.33	9.89	-0.56	2.32
	Tom	7.58	9.43	-1.85	4.35
	Group	8.65	9.77		
Contact (2, 4, 6, 8, 10, 12)	Dick	9.83	8.85	+0.98	3.76
	Don	9.39	9.13	+0.26	0.81
	Helene	9.42	9.04	+0.38	1.06
	Tom	9.40	7.45	+1.95	4.43
	Group	9.51	8.62		
Non-contact (1, 3, 5, 7, 9, 11)	Dick	10.00	10.00	0.00	
	Don	10.00	10.00	0.00	
	Helene	10.00	10.00	0.00	
	Tom	10.00	10.00	0.00	
	Group	10.00	10.00		
Aggressive (3, 4, 7, 8, 11, 12)	Dick	3.83	9.45	-5.62	11.90
	Don	1.65	4.84	-3.19	6.01
	Helene	0.38	3.16	-2.78	5.92
	Tom	2.30	7.02	-4.72	8.28
	Group	2.04	6.12		
Non-aggressive (1, 2, 5, 6, 9, 10)	Dick	9.58	3.51	+6.07	15.40
	Don	9.76	7.98	+1.78	5.08
	Helene	10.00	8.24	+1.76	7.98
	Tom	9.10	5.03	+4.07	7.98
	Group	9.61	6.19		

* Referring to categories in table 12.

TABLE 13—*Concluded*

BEHAVIOR CLASS	TEST ANIMAL	MEAN FREQUENCY PER TEN TRIALS		DIFF. (1st - 2d)	C.R.
		1st series	2d series		
Grooming (2, 10)	Dick	9.08	3.08	+6.00	13.90
	Don	8.78	7.39	+1.39	2.96
	Helene	9.41	7.80	+1.61	3.57
	Tom	8.80	4.04	+4.76	9.09
	Group	9.02	5.56		
Play-fighting (7, 8)	Dick	1.00	8.11	-7.11	17.80
	Don	0.09	3.33	-3.24	8.06
	Helene	0.00	1.84	-1.84	6.58
	Tom	0.10	4.96	-4.86	10.80
	Group	0.30	4.56		

Decreases in social behavior, contact, non-aggressive, and grooming behavior are found in the second series by these measures, along with increases in non-social, aggressive and play-fighting behavior. These results are consistent with those of the frequency data.

The outstanding difference between the first and second series was the change in living routine from 23 to 8 hours of daily isolation. The above results thus suggest that the longer period of daily social contact in the second series was associated with a decreased exhibition in the experimental situation of social, contact, non-aggressive, and grooming behavior, and an increase in non-social, aggressive, and play-fighting behavior.

2. *Differences in behavior with the preferred and non-preferred member of each stimulus pair.* In table 14 is given the mean frequency per ten trials for each subject with the preferred and non-preferred member of each stimulus pair. In the first series, all five subjects show consistent differences in only four of the eight types of behavior. That is, all five show greater frequency of social, contact, and grooming behavior with the preferred partner, and greater frequency of aggressive behavior with the non-preferred partner. In the second series the five subjects show

TABLE 14

Showing the mean frequency per ten trials of classes of behavior observed for all subjects with the preferred (P) and non-preferred (N) member of each stimulus pair. First and second series

BEHAVIOR CLASS	TEST ANIMAL	MEAN FREQUENCY PER 10 TRIALS							
		1st series				2d series			
		P	N	Diff. (P - N)	C.R.	P	N	Diff. (P - N)	C.R.
Social	Dick	9.75	6.15	+3.60	7.65	8.28	6.88	+1.40	3.26
	Don	8.50	4.92	+3.58	6.40	6.08	5.73	+0.35	0.70
	Gamma					6.66	4.32	+2.34	4.77
	Helene	7.00	5.83	+1.17	1.92	4.37	4.11	+0.26	0.52
	Rosy	8.00	4.75	+3.25	5.60				
	Tom	7.00	3.08	+3.92	6.65	5.67	4.06	+1.61	3.22
	Group	8.05	4.95			6.21	5.02		
Non-social	Dick	7.08	6.00	+1.08	1.77	9.36	9.00	+0.36	1.28
	Don	9.42	7.58	+1.84	4.14	7.86	7.70	+0.16	0.39
	Gamma					6.72	4.57	+2.15	4.39
	Helene	7.83	7.84	-0.01	0.02	8.54	9.59	-1.05	3.62
	Rosy	7.17	6.00	+1.17	1.92				
	Tom	6.42	4.92	+1.50	2.38	7.60	6.93	+0.67	1.48
	Group	7.58	6.47			8.20	7.56		
Contact	Dick	9.49	7.84	+1.65	3.18	7.55	7.35	+0.20	0.39
	Don	9.51	6.10	+3.41	5.08	8.97	8.09	+0.88	1.88
	Gamma					7.73	6.63	+1.10	1.73
	Helene	10.00	9.57	+0.43	1.79	7.38	8.10	-0.72	1.11
	Rosy	10.00	6.14	+3.86	6.04				
	Tom	9.88	6.22	+3.66	4.54	7.52	6.36	+1.16	1.71
	Group	9.77	7.17			7.83	7.31		
Non-contact	Dick	10.00	10.00	0.00		10.00	10.00	0.00	
	Don	10.00	10.00	0.00		10.00	10.00	0.00	
	Gamma					10.00	10.00	0.00	
	Helene	10.00	10.00	0.00		10.00	10.00	0.00	
	Rosy	10.00	10.00	0.00					
	Tom	10.00	10.00	0.00		10.00	10.00	0.00	
	Group	10.00	10.00			10.00	10.00		

TABLE 14—*Concluded*

BEHAVIOR CLASS	TEST ANIMAL	MEAN FREQUENCY PER 10 TRIALS							
		1st series				2d series			
		P	N	Diff. (P - N)	C.R.	P	N	Diff. (P - N)	C.R.
Aggressive	Dick	3.24	4.59	-1.35	1.87	9.31	9.09	+0.22	0.67
	Don	1.08	1.69	-0.61	1.05	3.68	4.82	-1.14	1.75
	Gamma					5.16	3.25	+1.91	2.82
	Helene	0.24	0.43	-0.19	0.65	3.38	2.53	+0.85	1.20
	Rosy	1.04	1.58	-0.54	0.93				
	Tom	1.19	5.14	-3.95	4.44	6.15	8.97	-2.82	5.03
	Group	1.36	2.69			5.53	5.73		
Non-aggressive	Dick	8.72	6.76	+1.96	3.11	1.95	3.41	-3.18	6.11
	Don	9.80	9.15	+0.65	1.66	7.18	6.64	-0.54	0.88
	Gamma					5.86	7.47	-1.61	2.49
	Helene	9.52	10.00	-0.48	2.10	5.95	7.85	-1.90	2.69
	Rosy	9.48	9.12	+0.36	0.82				
	Tom	9.17	8.52	+4.22	4.74	5.23	1.92	+3.31	5.08
	Group	9.34	8.52			5.24	5.46		
Grooming	Dick	8.12	5.68	+2.44	3.59	1.70	3.18	-1.48	2.94
	Don	8.53	7.79	+0.74	1.16	6.41	5.82	+0.59	0.91
	Gamma					4.84	5.83	-0.99	1.41
	Helene	9.64	8.57	+1.07	2.27	5.59	7.34	-1.75	2.38
	Rosy	8.96	7.37	+1.59	2.41				
	Tom	8.81	4.59	+4.22	4.74	4.59	1.03	+3.56	6.36
	Group	8.81	6.80			4.63	4.64		
Play-fighting	Dick	0.94	0.68	+0.26	0.65	6.54	7.12	-0.58	1.06
	Don	0.00	0.17	-0.17	1.00	2.82	2.09	+0.73	1.28
	Gamma					4.22	1.45	+2.77	4.77
	Helene	0.00	0.14	-0.14	1.00	1.90	1.27	+0.63	1.11
	Rosy	0.00	0.00	0.00					
	Tom	0.10	0.08	+0.02	0.11	4.95	4.10	+0.85	1.16
	Group	0.21	0.21			4.09	3.21		

complete agreement only in the greater frequency of social behavior with the preferred partner.

As shown in table 16 the results in terms of duration are con-

sistent with those in terms of frequency for the types of behavior just discussed. In the first series the average duration of social, contact, and grooming behavior was greater with the preferred partner, while the duration of aggressive behavior was greater with the non-preferred. In the second series the average duration of social behavior was again greater with the preferred partner.

Greater frequency and duration of social, contact, and grooming behavior were thus associated with the preferred partner of the stimulus pair in the first series, and greater frequency and duration of aggressive behavior were associated with the non-preferred partner. In the second series, greater frequency and duration of social behavior were associated with the partner of higher preference status.

3. *Differences in behavior with the relatively dominant and relatively subordinate member of the stimulus pair.* In table 15 is presented the mean frequency per ten trials of types of behavior with the more dominant and less dominant member of each stimulus pair. In the first series⁹ all five subjects showed a greater frequency of non-aggressive behavior with the more dominant animal. In the second series all five showed a greater frequency of both non-aggressive and grooming behavior with the more dominant animal. All five subjects in this series also exhibited a greater frequency of aggressive behavior and play-fighting with the less dominant member of the pair. The results in terms of duration, as presented in table 16, are consistent with these results.

Relations between aggressive behavior and dominance status are also found when the data are examined in other ways. In table 13 it will be noted that Tom and Dick, the two most dominant animals, also have the highest mean frequency of aggressive behavior and the lowest mean frequency of non-aggressive be-

⁹ Inasmuch as no dominance tests had been made during the first series, it was necessary to estimate the dominance order of the subjects in this series. No change was made in the relative status of Tom, Dick, Helene, and Don. Three experimenters, who had handled all five animals, independently ranked Rosy with respect to dominance status. All ranked her above Don and below the other three animals.

havior in both series. In table 17 the total frequency of aggressive acts (categories 3, 4, 7, 8) by the test animal toward each of its partners is given for the second series, in which aggressive behavior was abundant. The three subjects who held intermediate dominance status (Dick, Helene, Don) show without exception greater frequency of aggressive behavior toward partners subordinate to them than toward partners dominant over them. In the case of these three subjects the mean frequency of aggressive behavior toward a dominant partner was 12.5 and the mean frequency toward a subordinate partner was 49.2. All of Tom's partners were subordinate to him; he was aggressive 55 times to the two partners nearest to him in dominance status and 78 times to the two partners of lowest dominance status. All of Gamma's partners were dominant over her. She was aggressive 18 times to her two most dominant partners and 54 times to the two partners of lowest dominance status. Also presented in the table are the values of the ratios obtained by dividing the duration of aggressive behavior by the total duration of social behavior exhibited by the pair. These results are consistent with those in terms of frequency.

The results indicate that (1) the test animals were more aggressive toward the less dominant member of a stimulus pair; (2) test animals of highest dominance status were the most aggressive and least non-aggressive subjects in the group; (3) subjects of intermediate dominance status were more aggressive to partners subordinate to them than to partners holding higher dominance status than they; (4) subjects Tom and Gamma, occupying the highest and lowest rank in the dominance order, were more aggressive to partners of low dominance status than to partners of high dominance status.

4. *Comparison of behavior in the preference situation with behavior in the no-barrier situation.* In the foregoing attempt to determine the association of frequency and duration of types of behavior in the preference apparatus with the factors of length of isolation, relative preference status of the partner, and relative dominance status of the partner, it was possible to measure only two of the three factors in situations other than the preference

TABLE 15

Showing the mean frequency per ten trials of classes of behavior observed for all subjects with the dominant (D) and the subordinate (S) member of each stimulus pair. First and second series

BEHAVIOR CLASS	TEST ANIMAL	MEAN FREQUENCY PER 10 TRIALS							
		1st series				2d series			
		D	S	Diff. (D - S)	C.R.	D	S	Diff. (D - S)	C.R.
Social	Dick	7.42	8.50	-1.08	2.10	7.08	8.07	-0.99	2.30
	Don	4.92	8.50	-3.58	6.39	5.57	6.25	-0.68	1.40
	Gamma					5.10	5.89	-0.79	1.55
	Helene	7.00	5.83	+1.17	1.92	3.33	5.16	-1.83	3.69
	Rosy	7.58	5.17	+2.41	4.00				
	Tom	6.25	3.83	+2.42	3.84	5.99	3.75	+2.24	4.48
	Group	6.63	6.36			5.41	5.82		
Non-social	Dick	6.42	6.67	-0.25	0.41	9.34	9.06	+0.28	1.00
	Don	7.58	9.42	-1.84	4.14	7.50	8.06	-0.56	1.33
	Gamma					4.48	6.82	-2.34	4.78
	Helene	7.67	8.00	-0.33	0.63	8.60	9.54	-0.94	3.13
	Rosy	7.40	6.17	+0.83	1.36				
	Tom	6.67	4.67	+2.00	3.18	7.45	7.09	+0.36	0.80
	Group	7.07	6.99			7.47	8.11		
Contact	Dick	9.33	8.43	+0.90	2.01	7.72	7.23	+0.49	0.96
	Don	6.10	9.51	-3.41	5.10	8.13	8.92	-0.79	2.07
	Gamma					7.35	7.26	+0.09	0.15
	Helene	9.88	9.71	+0.17	0.78	8.91	6.97	+1.94	3.23
	Rosy	8.79	8.23	+0.56	0.94				
	Tom	8.93	8.48	+0.45	0.70	7.13	5.07	+2.06	2.89
	Group	8.60	8.87			7.85	7.09		
Non-contact	Dick	10.00	10.00	0.00		10.00	10.00	0.00	
	Don	10.00	10.00	0.00		10.00	10.00	0.00	
	Gamma					10.00	10.00	0.00	
	Helene	10.00	10.00	0.00		10.00	10.00	0.00	
	Rosy	10.00	10.00	0.00					
	Tom	10.00	10.00	0.00		10.00	10.00	0.00	
	Group	10.00	10.00			10.00	10.00		
Aggressive	Dick	3.03	4.41	-1.38	2.00	8.38	9.94	-1.56	4.86
	Don	1.69	1.08	+0.61	1.06	3.64	4.75	-1.11	1.71
	Gamma					3.57	5.13	-1.56	2.32
	Helene	0.24	0.43	-0.19	0.66	0.78	3.54	-2.76	5.64
	Rosy	1.21	1.29	-0.08	0.15				
	Tom	1.33	4.13	-2.80	3.39	5.65	10.00	-4.45	9.45
	Group	1.50	2.27			4.40	6.67		

TABLE 15—*Concluded*

BEHAVIOR CLASS	TEST ANIMAL	MEAN FREQUENCY PER 10 TRIALS							
		1st series				2d series			
		D	S	Diff. (D - S)	C.R.	D	S	Diff. (D - S)	C.R.
Non-aggressive	Dick	9.21	6.86	+2.35	4.35	2.65	2.58	+0.07	0.14
	Don	9.15	9.00	+0.15	0.32	7.76	6.17	+1.59	2.65
	Gamma					8.57	4.69	+3.88	6.36
	Helene	9.88	9.57	+0.31	1.15	7.02	5.35	+1.67	2.19
	Rosy	9.56	9.03	+0.53	2.16				
	Tom	9.20	7.83	+1.37	2.00	4.61	2.64	+1.97	2.80
	Group	9.40	8.46			6.12	4.28		
Grooming	Dick	8.31	6.18	+2.13	3.42	2.65	2.13	+0.52	1.04
	Don	7.80	8.53	-0.73	1.14	6.64	5.67	+0.97	1.52
	Gamma					6.73	3.98	+2.75	4.17
	Helene	9.40	8.86	+0.54	1.17	6.79	4.85	+1.94	2.52
	Rosy	8.46	8.23	+0.23	0.38				
	Tom	8.80	5.43	+3.37	4.50	3.91	1.80	+2.11	3.30
	Group	8.55	7.44			5.34	3.68		
Play-fighting	Dick	1.12	0.62	+0.50	1.22	6.10	7.42	-1.32	2.42
	Don	0.17	0.00	+0.17	1.02	1.21	3.58	-2.39	4.44
	Gamma					1.43	4.60	-3.17	5.41
	Helene	0.00	0.14	-0.14	1.00	0.36	2.32	-1.96	4.06
	Rosy	0.00	0.00	0.00					
	Tom	0.13	0.00	+0.13	0.99	4.35	5.00	-0.65	0.87
	Group	0.28	0.15			2.69	4.58		

situation. Length of isolation was determined by the caging of the animals outside of the preference apparatus, and relative dominance status was determined in an independent situation involving competition for food and for escape. It was, therefore, desirable to determine how preference status, as measured in the preference apparatus, influenced social behavior in a situation other than this apparatus. During the second series the subjects were placed, two at a time, in a detention cage in which there was no barrier between the partners, as has already been described.

The results of these observations indicate that the social be-

havior exhibited in a small area is only slightly influenced by the placing of a suitable barrier between the subjects. When the results for the four subjects (Dick, Don, Helene, Tom) used in both preference series and in the no-barrier situation are considered, it is found that social behavior was exhibited in 83 per cent of the three-minute periods in the preference apparatus and in 84 per cent of the three-minute periods in the detention cage. Table 18 shows the distribution of frequencies of the sub-classes of social behavior in each situation. When the Chi-square test (Fisher, 1938, p. 90) is applied to these two distributions, the

TABLE 16

Combined results for all subjects, showing mean duration in seconds per minute of classes of behavior observed when test animal was with the preferred (P), non-preferred (N), dominant (D), and subordinate (S) member of each stimulus pair. First and second series

BEHAVIOR CLASS	1ST SERIES					2D SERIES				
	P	N	D	S	All partners	P	N	D	S	All partners
Social.....	35.0	20.8	33.1	28.9	30.2	21.4	16.7	20.1	18.8	19.5
Non-social.....	11.8	28.9	14.7	15.1	16.3	30.9	34.0	31.3	32.9	32.2
Contact.....	57.2	50.0	54.7	38.5	55.7	48.6	47.0	49.4	46.0	47.6
Non-contact.....	2.8	10.0	5.3	21.5	4.3	11.4	13.0	10.6	14.0	12.4
Aggressive.....	3.4	8.9	3.5	5.5	5.0	24.8	26.7	19.7	29.4	26.0
Non-aggressive.....	56.6	51.1	56.5	54.5	55.0	35.2	33.3	40.3	30.6	34.0
Grooming.....	55.0	45.4	55.0	50.5	52.4	32.6	31.2	37.3	26.5	32.3
Play-fighting.....	1.3	0.3	1.7	0.2	1.0	17.8	17.4	12.0	22.3	17.6

value obtained is 0.783, and the probability that the two distributions are from the same population is greater than 0.80.

Inasmuch as each subject was presented with only one partner in the detention cage, rather than with two as in the preference apparatus, the data for each subject in table 19 have been divided into four groups corresponding to interaction with each of the four partners. The data for each subject are presented in terms of duration because the small number of trials greatly limited the sizes of differences in terms of frequency. As presented in the table the partners are ranked according to their

TABLE 17

Showing differences (a) in the frequency of aggressive behavior and (b) in the ratio of duration of aggressive behavior to total duration of social behavior with partners of different dominance status. Second series

Frequency of aggressive behavior by test animal

TEST ANIMAL	DOMINANT STATUS OF PARTNER					TOTAL FREQUENCY TO ALL PARTNERS
	1st Tom	2d Dick	3d Helene	4th Don	5th Gamma	
Tom		36	19	34	44	133
Dick	46		62	89	72	269
Helene	1	6		9	21	37
Don	5	9	8		42	64
Gamma	12	6	9	45		72
Total of group to each partner.....	64	57	98	177	179	

Relative duration of aggressive behavior by test animal

						AVERAGE RATIO TO ALL PARTNERS
Tom		.27	.74	.95	.81	.50
Dick	.70		.79	.83	.83	.65
Helene	.01	.01		.21	.22	.09
Don	.05	.08	.53		.57	.36
Gamma	.04	.01	.05	.87		.16
Average ratio of group to each partner.....	.28	.10	.55	.83	.64	

TABLE 18

Showing total frequencies of types of social behavior in the preference and no-barrier situations for four subjects

SITUATION	TOTAL TRIALS	FREQUENCY OF TYPES OF SOCIAL BEHAVIOR				TOTAL
		Contact	Non- contact	Aggressive	Non- aggressive	
Preference.....	1,248	940	1,033	476	773	3,222
No-barrier.....	128	108	108	50	90	356

preference status as determined in the regular preference tests of the second series. Thus, Dick's partners are Don, Tom, Gamma,

TABLE 19

Showing differences in total duration of grooming and play-fighting in the no-barrier situation with partners of different preference status

SUBJECT	GROOMING				PLAY-FIGHTING			
	Preference status of partner				Preference status of partner			
	1st	2d	3d	4th	1st	2d	3d	4th
Dick	Do* 663	<i>T</i> 1780	G 1621	H 748	<i>Do</i> 882	T 20	G 383	H 845
Don	H 561	<i>G</i> 770	T 70	Di 663	H 181	G 866	T 13	<i>Di</i> 882
Gamma	Do 770	<i>Di</i> 1621	H 1060	T 429	<i>Do</i> 866	Di 383	H 855	T 17
Helene	<i>T</i> 1322	G 1060	Di 748	Do 561	T 0	<i>G</i> 855	Di 845	Do 181
Tom	<i>Di</i> 1780	H 1322	G 429	Do 70	<i>Di</i> 20	H 0	G 17	Do 13

* The symbols Di, Do, G, H, T represent partners Dick, Don, Gamma, Helene, Tom respectively. The italicized symbol represents the partner engaging in the largest amount of grooming or play-fighting.

TABLE 20

Showing differences in frequency of grooming and play-fighting with partners of different preference status

SITUA- TION	TEST ANIMAL	GROOMING				PLAY-FIGHTING			
		Preference status of partner				Preference status of partner			
		1st	2d	3d	4th	1st	2d	3d	4th
1st series	Dick	* <i>R</i> 55	<i>T</i> 39	Do 29	H 14	R 0	T 7	Do 6	H 3
	Don	<i>R</i> 48	<i>H</i> 47	Di 23	T 15	R 0	H 0	Di 1	T 0
	Helene	<i>T</i> 43	<i>R</i> 40	Di 26	Do 32	T 0	R 0	Di 1	Do 0
	Rosy	<i>Di</i> 55	H 24	<i>Do</i> 29	T 20	Di 0	H 0	Do 0	T 0
	Tom	<i>H</i> 36	<i>Di</i> 34	R 18	Do 3	H 0	Di 1	R 0	Do 0
	Group	237	184	125	84	0	8	8	3
2d series	Dick	Do 11	<i>T</i> 26	G 18	H 24	<i>Do</i> 65	T 29	G 56	H 48
	Don	<i>H</i> 52	G 22	T 21	Di 44	H 5	<i>G</i> 37	T 5	Di 9
	Gamma	Do 12	<i>Di</i> 53	H 17	T 30	<i>Do</i> 65	T 29	G 56	H 48
	Helene	T 22	G 22	<i>Di</i> 44	Do 17	T 1	<i>G</i> 20	Di 4	Do 1
	Tom	<i>Di</i> 31	H 9	G 10	Do 2	<i>Di</i> 37	H 17	G 19	Do 13
	Group	128	122	110	117	156	108	88	80

* The italicized symbol represents for each test animal in the 1st series the two partners engaging in grooming most frequently; in the 2d series, the partners engaging in grooming or play-fighting most frequently.

and Helene, and are named according to rank in his order of preference. The values accompanying the name of each partner represent the total duration of grooming behavior or play-fighting behavior with the partner in their 2880 seconds together. The following relation between preference status and behavior is immediately apparent. With one exception the two animals most highly preferred by each subject in the preference situation are the partners engaging with the subject in the greatest amount of play-fighting or grooming behavior in the detention cage. Thus, Dick's most highly preferred partners were Don and Tom; in the detention cage Dick and Tom engaged in the greatest amount of grooming (1780 seconds); Dick and Don engaged in the largest amount of play-fighting (882 seconds). The same is true of Gamma's preferred partners, Don and Dick, of Helene's preferred partners, Tom and Gamma, and of Tom's preferred partners, Dick and Helene. Of Don's two preferred partners, Helene and Gamma, Gamma engaged with Don in the greatest amount of grooming, but Helene engaged in relatively little social activity with Don in this situation.

5. *Differences in frequency of grooming and play-fighting with partners of different preference status.* The results of the observations in the detention cage suggest this further analysis of behavior in the preference situation. In table 20, as in table 19, the partners of each test animal are rated according to preference status, and the frequency of grooming and of play-fighting is presented with the name of the partner. In the first series the two most highly preferred partners of each test animal, with the partial exception of Rosy, are also those which engaged most frequently in grooming with the test animal. In the second series one of the two most preferred partners is that which engaged most frequently in grooming, the other is that which engaged most frequently in play-fighting. An exception is found in the case of Helene, for Dick engaged most frequently in grooming with her but remained third in her preference order. In the second series the preferred grooming partner is a relatively dominant animal, while the preferred play-fighting partner is a relatively subordinate animal.

F. Discussion

In addition to the evidence advanced in the introduction to this study indicating that preference is shown in the living-quarters through the constant association of two animals among a larger group, or through the rivalry of two animals for the privilege of engaging a third in friendly behavior, the present experimental evidence indicates that these subjects also exhibited companionship preference in a testing situation in which they were free to choose between companions. Determination of factors responsible for companionship preference was not a primary purpose of this investigation. It is possible, however, to analyze the present data with respect to such factors as size, sex, age, amount of previous social contact and dominance status. The subjects were fairly well matched for size and age, and these factors do not appear to influence their preferences. All the animals in the first series had about the same amount of association with each other in their caging experience, with the exception of the twins, Tom and Helene, who had been together more consistently since birth than any other two animals in this colony. In the first series these two animals definitely preferred each other to all other animals. Helene, again in the second series, preferred Tom to all others in spite of the fact that she exhibited more social behavior with other animals in the group. Helene was second to Dick in the preference order of Tom in this series. Gamma, a relative newcomer to the group, received in the second series an average preference rank of 2.5 in the orders of the other four subjects. A possible effect of length of association on preference was exhibited only in the case of Tom and Helene.

No influence of dominance status on preference status which was consistent for all five animals was found. The more dominant member of the stimulus pair was preferred in 17 of the 30 pairs of the first series and in 15 of the 30 pairs of the second series. Dominance status appears to have been effective only in the case of Tom and Don. Tom, the most dominant animal of the group, preferred the two most dominant of his partners to the two least dominant in both series. Don, the lowest animal in dominance in the first series, and next to the lowest in the

second series, preferred in both series his two least dominant to his two most dominant partners.

The influence of sex is found only in the first series, when the most preferred partner of each test animal was of the opposite sex. Don, the male castrate, was the least popular member of the group in this series. In the second series, when aggressive behavior was more closely associated with the presence of a preferred animal, Don became the most preferred partner of both Dick and Gamma and served both of these largely in the rôle of companion for play-fighting.

The association between frequency of grooming and interaction with a preferred partner in the first series, and the association between frequency of grooming and play-fighting with preferred partners in both the preference and no-barrier situations of the second series, suggest that companionship preferences may be based to a large extent on activity preferences, and that partners are preferred in these situations because of their readiness to enter into preferred activities. The development of companionship preferences may thus depend on the formation of particular social habits with particular living-quarters partners. When a situation, or a period of isolation, produces a strong instigation for a particular type of social behavior, the subject selects that partner with which it has developed habits which include the present strongly instigated activity. In the first series, for example, play-fighting occupied less than 2 per cent of all time spent in social behavior and was not related to preference status. In the second series, however, when it occupied 29 per cent of all the time spent in social behavior, each test subject had one play-fighting companion among its two most preferred partners. Similarly grooming occupied 84 per cent of all the time spent in social behavior in the first series, and the two most preferred partners of each test subject were grooming companions. In the second series grooming represented only 54 per cent of the total duration of social behavior and only one grooming companion was found in the two most preferred partners of each subject.

The tentative outcome of these considerations is that com-

panionship preferences in the young chimpanzee are based on habits of social behavior developed with the partner in the living-quarters. The degree to which preference for a partner is exhibited is directly related to the strength of the instigation to enter into the activities which have become habitual in the interaction of the partners.

The factors of sex and size had possible relationships to dominance status. The dominance order was Tom, Dick, Helene, Don, Gamma. The rank order with respect to size was Tom, Helene, Gamma, Dick, Don. Both normal males were dominant in the group. Among the males the dominance order corresponded exactly to that of size. Among the females the same correspondence held, although the difference in dominance was much more definite than that in size.

Whereas the relationship between preference status and behavior was found in situations in which mutually adient social activity occurred, the relationship between dominance status and behavior was found in situations in which competitive and aggressive activity occurred. The behavior of the subjects suggests that aggression is the most important factor in their competitive behavior and in the development of relative dominance status. Aggression involves infliction of injury or punishment. The animal which consistently competes successfully by means of aggression directed towards its partners acquires habits of approach and aggression in competitive situations and furnishes conditions for the development in its partners of habits of withdrawal from punishment and from competition. When each of five animals develops these habits towards the others, the habits have characteristics which correspond closely to those presented by Allport (1937, p. 293) and Woodworth (1940, p. 392) as definitive of an attitude: they are determining tendencies or sets; they are directed toward a particular object, the partner; they are specific and they rank a series of partners with respect to punishment value on the basis of acquaintance with the partners. The manner in which dominance status influenced the social behavior of paired animals in this study was more clearly related to the operation of specific social attitudes than to the operation of either a drive or a trait of dominance.

VII. SUMMARY

A. *Experimental procedures*

1. The *companionship preferences* of a group of five pre-adolescent chimpanzees, two males, two females, and one male castrate, were measured by the method of paired comparisons. The experimental situation allowed the test animal to approach either one of the two stimulus animals and to have contact with it through a grille of iron bars. Each test was three minutes long; preference was scored on the basis of the greater part of the period spent with one of the stimulus animals. Each individual was tested for its relative preference for each of the other four members of the group which were presented in six different pairings. In the first series, covering a period of six weeks during which time the animals lived in isolation and had contact only during the test periods, each animal chose 20 times between each of six pairs, making 600 tests in all. In the second series of tests, covering a period of eight weeks, each animal chose 32 times between each pair, a total of 960 tests. During the second series the five animals were caged in groups of two and three during the night and were isolated only during the daytime.

2. The same animals were tested over a period of eight weeks for relative *dominance status*. Two situations were used, both of which induced competition between the animals, which were tested in pairs. In the first situation there was competition in regard to food which was made available to both members of a pair. In the second situation there was rivalry in regard to priority of escape from confinement in a strange situation. Each of the ten pairs of animals was given 8 preliminary and 16 regular food tests, and 4 preliminary and 8 regular escape tests.

3. Tests of *food-sharing* were conducted in the preference-test situation. At the end of each session of preference tests in the second series, the test animal was given 20 peanut kernels which it could either eat up at once, or, by approaching one of the stimulus cages, share with one or both of the stimulus animals. Each animal had 24 opportunities to share food with each of the four animals.

4. All *behavior* which occurred in the preference tests of both

series and in a no-barrier situation in the second series was observed and recorded by a technique patterned after a method previously used by others in studies of child behavior. This involved a second-by-second record of the behavior, in terms of type, frequency, and duration, of the test and stimulus animals in the 1560 three-minute preference tests and in the 160 three-minute observations in the no-barrier situation. The behavior was classified in twelve social and five non-social categories. These categories were defined in such a way that they could be recombined in any one of several pairs of mutually exclusive classes: social and non-social, aggressive social and non-aggressive social, contact social and non-contact social. The categories also provided measures of two specific patterns, grooming and play-fighting. The reliability of the method was tested in several ways. The data were then analyzed for the variation in frequency and duration of types of behavior with the main variables of the experiment.

B. Results

1. *Companionship preferences.* (a) In the first series of preference tests each animal exhibited a preference order which was perfectly consistent internally. That is, results of the paired comparisons permitted the ranking of the four stimulus animals (for each test animal) in a progressive order of preference. The preference ranks were also highly consistent from week to week in this series.

(b) In the second series of preference tests each test animal again had a preference order for the four partners which was perfectly consistent internally. In this series, however, there was some variability in the preference rankings of each animal from week to week; the variations that occurred usually did not involve a change of more than one step in rank.

(c) The rankings of the five stimulus animals by the five test animals were variable, so that the individuals cannot be ranked in a consistent order of preference for the group as a whole. The castrate male, Don, who in the first series of tests ranked either third or last in the preference order of all the test animals, provided the only instance of consistent ranking by the group.

2. *Dominance status.* (a) Results of the dominance tests were highly consistent. The relative dominance in a pair of animals as determined in one situation was substantiated in the other situation in all of the regular tests.

(b) The five subjects were ranked in a consistent, progressive order of dominance by both tests of dominance status.

(c) No relation was found between preference status and dominance status.

3. *Food-sharing.* (a) Food-sharing occurred in 16 per cent of the trials. The maximum amount of food shared in any one instance was all of the 20 kernels available; the usual amount was only one or two kernels.

(b) No relation was found between preference status and food-sharing.

(c) Food was shared only by subordinate animals with their dominant partners. A dominant animal was never observed to share food with a subordinate.

4. *Analysis of behavior.* (a) Social behavior occurred in 83 per cent of the 1720 three-minute periods and occupied 40 per cent of the 309,600 seconds during which the subjects were observed. A very large portion (87 per cent) of the social behavior occurred in the form of two distinct patterns, grooming and play-fighting.

(b) Significant differences were found in the social behavior of all subjects in the following comparisons: (1) behavior in the first series after 23 hours isolation (relatively more social, contact, non-aggressive behavior) versus behavior in the second series after 8 hours isolation (relatively more non-social and aggressive behavior); (2) behavior with the more preferred member of each stimulus pair (first series, more social, contact, grooming behavior; second series, more social behavior) versus behavior with the less preferred member; (3) behavior with the more dominant member of each stimulus pair (first series, more non-aggressive behavior; second series, more non-aggressive and grooming behavior) versus behavior with the less dominant member (second series, more aggressive and play-fighting behavior).

(c) With slight deviations, in the first series the test animals

preferred most highly the two partners which engaged in grooming most frequently; in both the preference tests and no-barrier situation of the second series, one of the two most preferred animals was that which engaged most frequently in grooming and the other was that which engaged most frequently in play-fighting.

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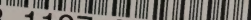
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